IN THE CLAIMS

Claims 1-17 (Cancelled)

18. (Currently Amended) An apparatus, comprising:

a memory, storing parameters of a model of a refrigeration system derived from a refrigeration system configuration and measurements of actual operational parameters of the refrigeration system in a known state;

at least one input adapted to receive operational ~~for receiving~~ physical parameters sufficient for performing a thermodynamic analysis of operation of the refrigeration system;

a processor for estimating a difference in operating cost due to a deviance of the refrigeration system in an operating state from the refrigeration system in the known state by performing a thermodynamic analysis of the refrigeration system in ~~an~~ the operating state based on at least the at least one input and ~~determining consistency of the thermodynamic analysis with~~ the stored parameters in the memory; and

an output for presenting ~~an~~ the estimate of the difference in operating cost due to the deviance ~~from an optimal state of the refrigeration system based on said thermodynamic analysis and said determined consistency~~.

19. (Previously Presented) The apparatus according to claim 18, wherein said processor further estimates a refrigeration efficiency of the refrigeration system in an operational state based on the thermodynamic analysis, further comprising an output adapted to alter a process variable of the refrigeration system during efficiency measurement and calculating a process variable level which achieves an optimum efficiency.

20. (Previously Presented) The apparatus according to claim 18, further comprising a control for altering physical parameters by altering at least one of an oil concentration in an evaporator and a refrigerant charge of said refrigeration system in dependence on at least said output.

21. (Currently Amended) A method for determining a deviance from optimum of a refrigeration system, comprising:

defining a first thermodynamic model of a refrigeration system in an optimal state based on measurements of actual operating parameters of the refrigeration system an actual costs of operation of the refrigeration system;

obtaining physical parameters sufficient for performing a thermodynamic analysis of the refrigeration system at a time when the refrigeration system is not performing optimally;

automatically performing a thermodynamic analysis of the refrigeration system based on the obtained physical parameters to define a second thermodynamic model;

~~determining a consistency of the thermodynamic analysis~~ comparing the first thermodynamic model to the second thermodynamic ~~with the defined~~ model of the refrigeration system; and

outputting ~~an~~ a quantitative estimate of an operating cost of deviance of the state of the refrigeration system at the time when the refrigeration system is not performing optimally from the determined optimal state of the refrigeration system based on said comparing ~~thermodynamic analysis and said determined consistency~~.

22. (Original) The method according to claim 21, wherein said estimate of deviance is used to determine a need for refrigeration system service.

23. (Currently Amended) The method according to claim 21, wherein said ~~estimate of deviance~~ thermodynamic analysis is used to estimate a refrigeration system capacity.

24. (Original) The method according to claim 21, wherein said thermodynamic analysis relates to a state of the refrigeration system, further comprising the step of monitoring refrigeration system performance in real time over a range of operating conditions to determine operating-condition sensitive physical parameters.

25. (Currently Amended) The method according to claim 21,

~~wherein said thermodynamic analysis comprises~~ further comprising estimating an efficiency of the operating refrigeration system;

the method further comprising the steps of:

automatically altering a process variable of the operating refrigeration system;

calculating a refrigeration system characteristic based on an analysis of ~~obtained~~ physical parameters in conjunction with ~~after~~ said alteration; and

optimizing ~~a~~ the process ~~parameter~~ variable level in accordance with the determined refrigeration system characteristic to maximize an efficiency of the operating refrigeration system with respect to the process variable.

26. (Previously Presented) The method according to claim 25, wherein the process variable is compressor oil dissolved in a refrigerant in an evaporator of the refrigeration system.

27. (Original) The method according to claim 25, wherein the process variable is refrigerant charge condition.

28. (Original) The method according to claim 25, wherein an optimum efficiency is determined based on surrogate process variables.

29. (Previously Presented) The method according to claim 25, wherein an operating point of the refrigeration system is maintained by closed loop control based on the determined optimum efficiency process variable level.

30. (Previously Presented) The method according to claim 25, wherein the process variable is compressor oil dissolved in a refrigerant in an evaporator of the refrigeration system, and wherein the process variable is altered by separating oil from refrigerant in the refrigeration system.

31. (Original) The method according to claim 21, further comprising the step of predicting a cost-benefit of a service operation on said refrigeration system to correct at least a portion of the deviance from said optimal state.

32. (Currently Amended) The method according to claim 21, further comprising the steps of:

determining a sensitivity of the refrigeration system to perturbations of at least one operational parameter;

defining an efficient operating regime for the refrigeration system based on the determined sensitivity, said efficient operating regime encompassing a range of the at least one operational parameter; and

performing a service of the refrigeration system to bring the at least one operational parameter within the range ~~efficient operating regime~~ when the refrigeration system is operating outside the defined efficient operating regime and a correction thereof is predicted to be cost-efficient.

33. (Currently Amended) The method according to claim 32, wherein the efficient operating regime ~~has~~ encompasses a non-trivial double ended range of ~~values~~ the at least one operational parameter, and continued operation of the refrigeration system follows a consistent trend in change in operating point from a beginning of cycle operating point to an end of cycle operating point, wherein the service alters the at least one operational parameter to within a boundary of the non-trivial double ended range of values near the beginning of cycle operating point.

34. (Previously Presented) The method according to claim 32, wherein the operational parameter is oil concentration of a refrigerant in an evaporator of the refrigeration system.

35. (Previously Presented) The method according to claim 32, wherein the service comprises a purification of a refrigerant within the refrigeration system.

36. (Original) The method according to claim 32, wherein the at least one operational parameter is estimated by measuring an energy efficiency of the refrigeration system.

37. (Original) The method according to claim 21, further comprising the step of predicting a refrigeration capacity of the refrigeration system.

38. (Currently Amended) The method according to claim 21, further comprising the steps of:

defining cost parameters of operation of the refrigeration system;

determining usage parameters of the refrigeration system;

predicting a thermodynamic effect of a service procedure on a machine with respect to efficiency;

estimating a cost of the service procedure; and

conducting a cost-benefit analysis based on the operation cost parameters, usage parameters, predicted thermodynamic effect and estimated cost.

39. (Currently Amended) A method, comprising the steps of:

thermodynamically modeling operation of a refrigeration system comprising a refrigerant having a refrigerant purity and a compressor operating at a compressor power, by acquiring actual operating parameters, to generate a thermodynamic model, and ~~a~~ determining a sensitivity of ~~an optimum state~~ the thermodynamic model of the refrigeration system to perturbations with respect to at least the refrigerant purity and a superheat level ~~, the refrigeration system comprising a refrigerant having a refrigerant purity and a compressor operating at a compressor power, with respect to at least the refrigerant purity and a superheat level~~;

measuring an actual performance of the refrigeration system;

predicting a thermodynamic effect of an alteration of the refrigerant purity and the compressor power with respect to the measured actual performance ~~and the thermodynamic model based on at least a consistency of the actual performance of the refrigeration system with the performance of the refrigeration system at the optimum state~~ and the determined sensitivity;

altering the refrigerant purity and the compressor power to in dependence on the predicted thermodynamic effect on ~~achieve a predicted optimum condition of~~ the refrigeration system under operating conditions.

40. (Original) The method according to claim 39, wherein compressor power is modulated by at least one of speed control, duty cycle control, compression ratio, and refrigerant flow restriction.

41. (Original) The method according to claim 39, wherein refrigerant purity is altered by changing a level of non-condensible gasses therein.

42. (Original) The method according to claim 39, wherein the predicting step comprises using a genetic algorithm.

43. (Currently Amended) A method, comprising the steps of:

performing a thermodynamic analysis of a refrigeration system based on actual operational parameters to derive a thermodynamic model of the refrigeration system;

~~to determine~~ determining an ~~optimal state~~ efficiency of the refrigeration system based on the thermodynamic model of the refrigeration system;

determining a cost-efficient optimum range of operation of the refrigeration system based on the determined efficiency, a cost associated with operation of the refrigeration system in a respective operating state, and a cost associated with an alteration of at least one operating physical parameter of the refrigeration system to a respective different operating state;

~~performing a consistency analysis of~~ analyzing the thermodynamic model of the refrigeration system with respect to a set of measured thermodynamic data of the refrigeration system during operation at an operating state ~~dependent on a set of operating physical parameters~~; and

presenting an estimate of a deviance of the operating state from the ~~an~~ optimal range ~~state~~ of the refrigeration system, sensitive to at least said analyzing ~~thermodynamic analysis and said consistency analysis~~.

44. (Currently Amended) The method according to claim 43, further comprising the steps of:

~~estimating a refrigeration efficiency of the refrigeration system in an operational state;~~

generating a control signal adapted to alter a ~~process variable~~ base level of at least one operating physical parameter of the refrigeration system during efficiency measurement; and

calculating a ~~process variable~~ revised level of the at least one operating physical parameter within the optimal range which achieves an ~~optimum~~ increased efficiency over the base level ~~, said optimal state being responsive to the optimal efficiency~~.

45. (Previously Presented) The method according to claim 43, further comprising altering the operating state of the refrigeration system by altering at least one physical parameter selected from the group consisting of an oil concentration in an evaporator and a refrigerant charge of said refrigeration system.

46. (Currently Amended) A method for analyzing a refrigeration system, comprising measuring physical parameters sufficient for performing a thermodynamic analysis of refrigeration system operation ~~and performing a thermodynamic analysis of the refrigeration system~~, determining a model of the refrigeration system which defines a refrigeration system configuration based on a thermodynamic analysis of the measured physical parameters; determining a sensitivity of an efficiency of the refrigeration system to changes in physical parameters ~~having~~ ~~an optimum state~~ based on ~~prior~~ measurements of refrigeration system performance under a plurality of different operating conditions, ~~and~~ estimating a deviance from the ~~optimum state~~ defined system configuration of the refrigeration system, by performing ~~a consistency~~ an analysis of the model of the refrigeration system ~~derived from the thermodynamic analysis~~ and measured operating parameters of the refrigeration system ~~at a time when the refrigeration system is not operating at the optimum state~~, and outputting the estimate of the deviance ~~from the optimal state of the refrigeration system based on said consistency analysis~~.

47. (Previously Presented) The method according to claim 46, wherein said estimate of deviance is used to determine at least one of a need for refrigeration system service and an estimate a refrigeration system capacity.

48. (Currently Amended) The method according to claim 46, ~~wherein said thermodynamic analysis relates to a state of the refrigeration system,~~ further comprising the step of monitoring refrigeration system performance in real time over a range of operating conditions to determine operating-condition sensitive physical parameters.

49. (Currently Amended) The method according to claim 46, wherein ~~said thermodynamic analysis comprises estimating an efficiency of the operating refrigeration system; said~~ method further ~~comprising~~ comprises the steps of: altering a ~~process variable~~ physical parameter of the refrigeration system; calculating a refrigeration system efficiency change based on ~~characteristic based on an analysis of obtained physical parameters after~~ said alteration; and optimizing a ~~process variable~~ physical parameter level with respect to a cost of effecting a respective physical parameter level and a benefit of a change in efficiency of the refrigeration system ~~in accordance with the determined refrigeration system characteristic~~.

50. (Currently Amended) The method according to claim 49, wherein an operating point of the operating refrigeration system is maintained by closed loop control based on the determined optimum physical parameter ~~efficiency process variable~~ level.

51. (Currently Amended) The method according to claim 46, wherein the ~~process variable~~ physical parameters comprise ~~comprises~~ compressor oil dissolved in a refrigerant in an evaporator of the refrigeration system.

52. (Currently Amended) The method according to claim 51, wherein the ~~process variable~~ amount of compressor oil dissolved in the refrigerant in the evaporator of the refrigeration system is altered by purifying refrigerant in the refrigeration system.

53. (Currently Amended) The method according to claim 46, wherein the ~~process variable comprises~~ physical parameters comprise refrigerant charge condition.

54. (Currently Amended) The method according to claim 46, wherein an optimum efficiency state of the refrigeration system is determined based on surrogate process variables and the determined model.

55. (Currently Amended) The method according to claim 49, wherein the ~~process variable~~ physical parameter is altered by purifying refrigerant in the refrigeration system.

56. (Currently Amended) The method according to claim 46, further comprising the step of predicting a cost-benefit of a service operation on said refrigeration system to correct at least a portion of the deviance ~~from said optimal state~~.

57. (Currently Amended) The method according to claim 46, further comprising the steps of:

~~determining a sensitivity of the refrigeration system to perturbations of at least one operational parameter;~~

defining an efficient operating regime for the refrigeration system ~~based on the determined sensitivity~~;

determining a cost servicing the refrigeration system from an operating state outside the efficient operating regime to an operating state within the efficient operating regime; and

servicing the refrigeration system to bring the refrigeration system from an operating state outside the efficient operating regime to an operating state ~~at least one operational parameter~~ within the efficient operating regime when ~~the refrigeration system is operating outside the defined efficient operating regime and~~ a correction thereof is predicted to be cost-efficient based on at least the determined sensitivity, a predicted increase in efficiency as a result of the servicing, and the determined cost.

58. (Currently Amended) The method according to claim 57, wherein the efficient operating regime has a non-trivial double ended range of values, and continued operation of the refrigeration system follows a consistent trend in change in operating point from a beginning of cycle operating point to an end of cycle operating point, wherein the service alters the at least one operational parameter to within a boundary of the non-trivial double ended range of values near the beginning of cycle operating point, and wherein a cost-efficiency is further predicted based on a duration that the refrigeration system will remain within the efficient operating regime.

59. (Previously Presented) The method according to claim 46, further comprising the steps of: defining cost parameters of operation of the refrigeration system;

determining usage parameters of the refrigeration system; predicting a thermodynamic effect of a service procedure on a machine with respect to efficiency; estimating a cost of the service procedure; and conducting a cost benefit analysis based on the operation cost parameters, usage parameters, predicted thermodynamic effect and estimated cost.